Vol. 41 No. 7

BULLETIN

OF THE

TORREY BOTANICAL CLUB

JULY, 1914

A black-soil prairie station in northeastern Illinois

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(WITH SEVEN TEXT FIGURES)

The prairie station described in this account is an example of perhaps the most luxuriant type of prairie, the mesophytic prairie-grass of the eastern border of the prairie region. This type is particularly well developed in the upper Wisconsin glaciation of northeastern Illinois, and until recently small and scattered areas of this type of prairie were still abundant west of Chicago as far as the Fox River and beyond. In the last ten years, however, the extension and development of suburban areas, and disturbance of relic colonies of prairie along railroad rights-of-way, have diminished the areas of original prairie to a small fraction of their recent extent. The particular area described possibly owes its survival to the fact that it is not large, and that it is nearly surrounded by forest and by prairie sloughs.

The station lies immediately north of the tracks of the Chicago Great Western railroad, very near the stopping-place of the Aurora, Elgin, and Chicago electric road known as Stratford Hills. It is one mile east of Elmhurst, and lies at the summit of a morainal ridge. The boundary separating Cook and Du Page counties passes through the area, which may conveniently be known as the county line prairie. The forest adjoining is also of interest to botanists, and the border zone between prairie and forest is still in good condition. The writer first visited the locality in 1905, and has made observations there and near by during four summers since that time. He wishes to express obligation to

[The BULLETIN for June (41: 319–350. *pl. 8*) was issued 22 Jl 1914.]

Dr. H. A. Gleason, who has accompanied him to the area, for the use of some of his notes. The accompanying sketch map shows very well the local distribution of the plant associations of the immediate vicinity. The length of the area mapped is about 600 feet. Just south of it is the Great Western railroad; to the east lies a blue-grass pasture and a picnic ground, with many of the original trees, but with the ground cover replaced by blue-grass; on the west the clover field continues; on the north the clover field, with its line of prairie sloughs, and the forest, continue also.

Local distribution of the plant associations of the county line station would be of little significance of itself, but there is one condition which this area has in common with others in northern and central Illinois: the forest is to the east of a line of sloughs, which may have served to protect it from the inroads of prairie fires. In this region forest areas are much more frequent and more extensive just east of streams and sloughs than just on the western side. Prairie fires, in former times very prevalent, traveled generally from west to east, in the direction of the prevailing winds. The bearing of these facts on vegetational history in the transition area between interior prairie and eastern forest regions has been developed by Gleason.* At the county line station, the narrow strip of prairie which separates the forest area mapped into a woodland on the north and several small groves on the south, may have invaded the formerly more extensive forest by the aid of prairie fires which were not stopped by the line of sloughs. It is seen on the map that the tongue of prairie extending into the forest is in line with the conspicuous gap in the series of prairie sloughs.

Established black-soil prairie of the eastern part of the prairie region, in its original condition, may be thought of as a luxuriant grassland with a large number of plant species and with very many local appearances, caused by local dominance or abundance of one or several species. The surface is usually slightly undulating, and in the recently glaciated areas stream development is poor, so that depressions have very wet or submerged soil, and elevations may at times be very dry. The local variation in soil

* Gleason, H. A. An isolated prairie grove and its phytogeographical significance. Bot. Gaz. 53: 38–49. *f. 1, 2.* 1912.

moisure therefore is rapid, though gradual. The species composition of the prairie growth changes with the soil moisture, and a complete transitional series of prairie growths can be recognized.

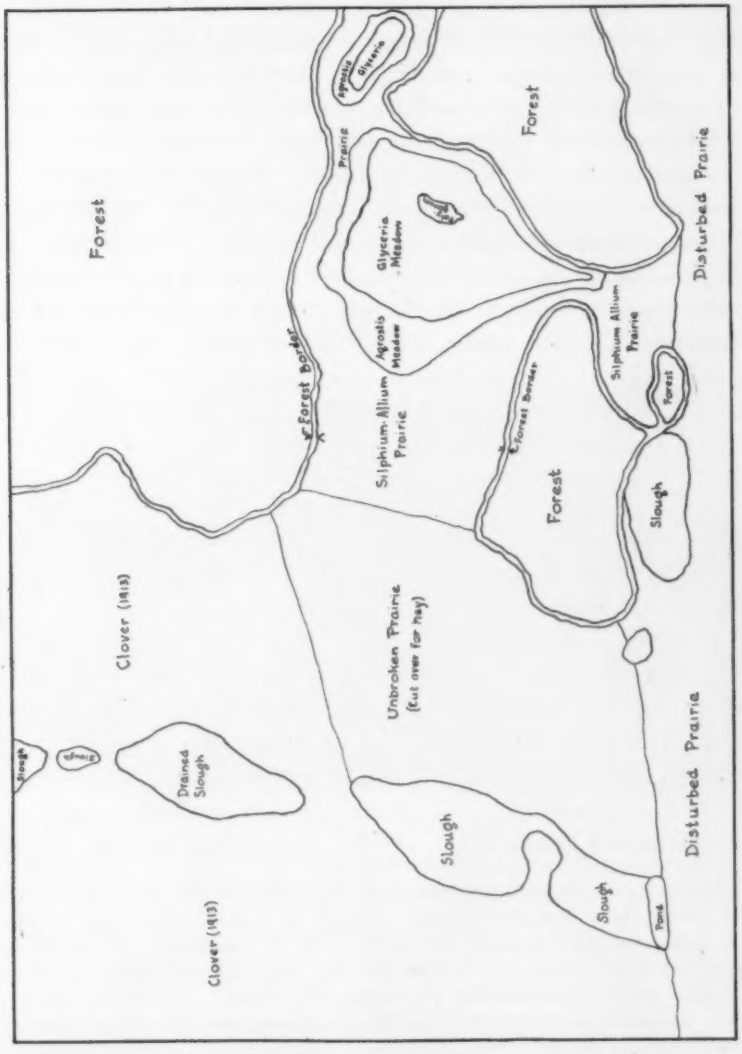

FIG. 1. Map of the county line station.

It will perhaps be helpful to regard the mean and the two extreme conditions of this series as constituting distinct plant associations, which may be called (1) xerophytic prairie-grass, (2) mesophytic

prairie-grass, and (3) hydrophytic or swamp prairie, or fen. It should be noted that these intergrade, passing into one another gradually, instead of alternating sharply, and that many species tolerate a wide range of soil moisture and of other environmental conditions, so that some species are found abundantly in more than one association. Some species, too, reach greatest abundance in transitional growths intermediate between two associations.

The xerophytic prairie-grass association.—This growth is not very extensively developed in upper Wisconsin glaciation of northeastern Illinois. Its best representative is the *Silphium laciniatum* consocies. The dominant species, often called the compass-plant, is very conspicuous. This type of prairie is rather locally seen in eastern Du Page County, and is hardly at all represented at the county line. Following is a list of species typical not only of the *Silphium laciniatum* prairie, but of the xerophytic prairie-grass association in general, as represented in eastern Du Page County.

*SPECIES TYPICAL OF XEROPHYTIC PRAIRIE-GRASS

d or ld *Andropogon scoparius*, ch	i *Verbena stricta*
l *Andropogon furcatus*, m	l *Physalis virginiana*
l *Sorghastrum nutans*, m	l *Liatris scariosa*
l *Panicum virgatum*	lf *Solidago nemoralis*
l *Stipa spartea*	f *Solidago canadensis*
l *Sporobolus heterolepis*, m	lf *Solidago serotina*
f *Koeleria cristata*	lf *Solidago rigida*, ch
l *Comandra umbellata*	i *Aster sericeus*
f *Rosa humilis*	f *Aster multiflorus*, ch
l *Cassia Chamaecrista*	i *Erigeron ramosus*

* Notation as used in the above table of species, and in other tables of this article, is as follows: symbols to the left of the species name have to do with frequence or abundance of the species in the station or in the association; d = dominant, a = abundant, f = frequent, i = infrequent, l = local, of scattered distribution, or prefixed = locally; symbols to the right of the name have to do with the degree to which the species is characteristic of this or of other associations and habitats; ch = a character species for the association or habitat; m = rather more typical of, or frequent in, comparatively mesophytic situations; x = rather more typical of comparatively xerophytic situations, or a relic from xerophytic prairie; h = rather more typical of, or a relic from, comparatively hydrophytic communities, or in very local depressions within mesophytic prairie growths.

l *Baptisia bracteata*
f *Amorpha canescens*, ch
f *Petalostemum purpureum*
l *Tephrosia virginiana*
i *Desmodium illinoense*
lf *Lespedeza capitata*
f, la *Euphorbia corollata*, ch
i *Oenothera biennis*
i *Asclepias tuberosa*
l *Asclepias verticillata*, ch
l *Convolvulus sepium*
i *Lithospermum canescens*, ch
f, ld *Silphium laciniatum*, ch
lf *Silphium integrifolium*, ch
i, la *Heliopsis scabra*, ch
f *Rudbeckia hirta*, m
i, la *Brauneria pallida* (seldom seen in e. Du Page Co.)
f, la *Lepachys pinnata*, ch
lf *Helianthus scaberrimus*, ch
i *Helianthus occidentalis*
i *Helianthus Maximiliani*
lf *Achillea Millefolium*
i *Cirsium discolor*

The mesophytic prairie-grass association.—This type of prairie is more generally distributed within the area of study than is the

FIG. 2 FIG. 3 FIG. 4

FIG. 2. A fragment in the mesophytic prairie-grass association, mixed grass consocies; a rather dry spot, *Euphorbia corollata* locally conspicuous; west of Elmhurst.

FIG. 3. A moister spot close to the first, with *Eryngium* and *Parthenium* in flower.

FIG. 4. At the county line; mesophytic prairie-grass, with *Eryngium* and *Silphium terebinthinaceum; Allium* abundant and conspicuous; behind is lower ground with *Agrostis* and *Glyceria*.

xerophytic prairie-grass. There are several well-defined representatives of the mesophytic association. One is dominated by the tall grass *Andropogon furcatus*, often with hardly any other

species present; one is dominated by a number of grass species (the mixed consocies of mesophytic prairie-grass); and one is dominated by the large rosin-plant *Silphium terebinthinaceum* and by grasses. All of these three consocies are well developed in and near the county line prairie. The best area of the association seen is the mixed grass growth shown on the map near the left, adjoining the clover field; this has been mowed for hay each summer. The following species, mostly those of early summer, have been observed here:

MIXED CONSOCIES OF MESOPHYTIC PRAIRIE-GRASS, COUNTY LINE

l *Equisetum arvense*
f, ld *Panicum Scribnerianum*, ch
li *Stipa spartea*, x
f, ld *Sporobolus heterolepis*, ch
i, ld *Koeleria cristata*
i, ld *Poa compressa*, ruderal ?
l *Bromus Kalmii*, ch
l *Elymus canadense*
li *Tradescantia reflexa*
f *Allium cernuum*, ch
li *Lilium canadense*
li *Spiranthes cernua?*
li *Polygonum* sp.
li *Heuchera hispida*
la *Fragaria virginiana*
i *Amorpha canescens*, x
f *Lathyrus palustris*
f *Viola pedatifida*, ch
la *Eryngium yuccifolium*, h, ch
i *Oxypolis rigidior*, h
i *Dodecatheon Meadia*, h, ch
li *Asclepias tuberosa*, x
i *Asclepias Sullivantii*, h
f *Phlox glaberrima*, ch
lf *Phlox pilosa*, h
lf *Monarda mollis*
lf *Pycnanthemum virginianum*, ch
i *Castilleja coccinea*, ch
lf *Pedicularis canadensis*
f *Lobelia spicata*, ch
li *Solidago rigida*, x
li *Erigeron ramosus*
i, la *Antennaria plantaginifolia*
f, ld *Silphium terebinthinaceum*, ch
li *Silphium integrifolium*, x
lf *Parthenium integrifolium*, ch
f *Rudbeckia hirta*, ch
i *Cirsium Hillii*, h, ch
i *Krigia amplexicaulis*, h, ch

Another very representative station of practically the same kind of prairie is seen in a fenced-in triangular area at the intersection of the Illinois Central and Aurora, Elgin, and Chicago rights-of-way somewhat less than a third of a mile west of the Elmhurst station of the latter railroad. A tabulation of the plant population of an area about thirty feet square is here given. It was made August 18, 1913.

MIXED CONSOCIES OF MESOPHYTIC PRAIRIE-GRASS, WEST OF ELMHURST

i, ld *Andropogon scoparius*, x
a, ld *Andropogon furcatus*, ch
f, ld *Sorghastrum nutans*, ch
f, ld *Panicum* sp., near *P. nitidum*
li *Stipa spartea*
f, ld *Sporobolus heterolepis*, ch
i, ld *Poa compressa*, ruderal ?
lf *Carex* sp.
lf *Juncus* sp.
li *Sisyrinchium* sp.
lf *Rosa humilis*
la *Euphorbia corollata*, x
i *Viola pedatifida*, ch
lf *Eryngium yuccifolium*, h, ch
i *Dodecatheon Meadia*, h, ch
i *Galium* sp.
i *Solidago canadensis*
lf *Solidago rigida*, x
lf *Aster Novae-Angliae*, ch
lf *Antennaria plantaginifolia*
f, ld *Silphium terebinthinaceum*, ch
lf *Parthenium integrifolium*, ch
i *Ambrosia artemisiifolia*
i *Rudbeckia hirta*, ch
i *Lepachys pinnata*

FIG. 5 FIG. 6

FIG. 5. Mesophytic prairie-grass at the county line station. The boundary is seen between the area regularly cut over for hay, and the undisturbed *Silphium terebinthinaceum* consocies, in which *Allium cernuum* is abundant and conspicuous.

FIG. 6. The *Liatris spicata* consocies of the swamp prairie or fen association.

The *Silphium terebinthinaceum* consocies is very distinctive in appearance, as the principal dominant is so conspicuous. Grasses

and most of the species of the mixed consocies occur here also, and no separate list is accordingly given for the *Silphium* growth. The areas labeled *Silphium-Allium* prairie in the map belong to this consocies. Local abundance of *Allium cernuum* is frequently seen in mesophytic prairie-grass of very rich, moist soil. This may be called the *Allium* society. *Allium canadense* sometimes replaces *Allium cernuum*. Certain species not listed from the two stations above mentioned appear in the following table:

ADDITIONAL SPECIES OF MESOPHYTIC PRAIRIE-GRASS

lf	*Hypoxis hirsuta*, h	lf	*Stachys palustris*, h
lf	*Oxalis stricta*	lf	*Eupatorium perfoliatum*
la	*Viola papilionacea*	la	*Helianthus grosse-serratus*
l	*Asclepias syriaca*	f	*Achillea Millefolium*
la	*Convolvulus sepium*	i	*Senecio Balsamitae*
i	*Physostegia virginiana*, h		

The swamp-prairie or fen association.—The hydrophytic extreme of prairie-grass passes insensibly, in places, into marsh associations; in other places there is conspicuous zonation, the boundaries following contour lines about depressions. One of the most distinctive appearances of swamp prairie is the *Liatris spicata* consocies, which has been rather fully described by Gates.* Scattered representatives of the blazing-star prairie are found in eastern Du Page County, though formerly they were more abundant. There is also a mixed consocies, variable in composition, in which umbellifers are frequently prominent. The meadow rue, *Thalictrum dasycarpum*, sometimes marks a well-defined zone. The species typical of the hydrophytic prairie are here listed. Many of them persist as relics in mesophytic growths.

SPECIES TYPICAL OF SWAMP PRAIRIE OR FEN

l	*Calamagrostis canadensis*	f	*Asclepias incarnata*, ch
l	*Spartina Michauxiana*	i	*Asclepias Sullivantii*
l	*Glyceria nervata*	f	*Phlox pilosa*
l	*Cyperus* sp.	l	*Veronica virginica*

* Gates, F. C. The vegetation of the beach area in northeastern Illinois and southeastern Wisconsin. Bull. Ill. State Lab. Nat. Hist. **9**: 255–372. (*Liatris spicata* prairie, pp. 301–303.) 1912.

l	*Iris versicolor*, ch	l, i	*Valeriana edulis*
f	*Thalictrum dasycarpum*, ch	l, i	*Lobelia syphilitica*
i	*Hypericum* sp.	l, f	*Eupatorium perfoliatum*, m
f, ld	*Eryngium yuccifolium*, ch	ld	*Liatris spicata*, ch
f	*Cicuta maculata*, ch	l	*Solidago Riddellii*, m
i	*Thaspium aureum*	l	*Solidago ohioensis*
f	*Oxypolis rigidior*, ch	i	*Aster paniculatus?*
l, i	*Gentiana Andrewsii?*	lf	*Parthenium integrifolium*, m
l	*Apocynum cannabinum*	i	*Senecio Balsamitae*

What may be called the *Eryngium* consocies of swamp prairie is characterized by dominance of this peculiar umbellifer, and corresponds fairly well with the *low prairie* of Cowles.* This growth shades into the *Silphium terebinthinaceum* consocies of the mesophytic prairie-grass association, *Silphium* and *Eryngium* frequently being seen together in about equal abundance. This is then the transitional growth between hydrophytic and mesophytic prairie. The plants conspicuous in this intermediate prairie are marked "h, ch" in the list of mesophytic prairie-grass species.

The marsh associations.—Areas of marsh vegetation are usually scattered and not large. There are now few areas of open water, since many of the ponds and swamps west of Chicago have been artificially drained. Marsh growths are commonly dominated by a single or by very few plant species. Prominent among these are *Spartina Michauxiana*, *Calamagrostis canadensis*, *Phragmites communis*, *Glyceria nervata*, *Scirpus lineatus*, and *Typha latifolia*. Willows (*Salix longifolia*) and cottonwoods (*Populus deltoides*) are able to establish themselves on the margins of some of these swamps, particularly in mud flats left by summer shrinking of ponds. A small pond near the southwest corner of the area mapped, and the slough directly east of this pond, are thus margined with good-sized trees.

The zone marked "*Agrostis*" in the map is probably disturbed swamp prairie. It is now dominated by the single grass species *Agrostis alba* (red-top), and there are also a few swamp prairie plants, as *Cicuta maculata*. Lower ground is occupied by a vir-

* Cowles, H. C. The physiographic ecology of Chicago and vicinity. Bot. Gaz. 31: 73–108, 145–182. 1901. (Low prairie, p. 156.)

tually pure growth of *Glyceria nervata*, which thus forms an inner zone. The large depression in the map has a deeper region occupied by a smartweed with large hairy leaves (*Polygonum amphibium* var. *Hartwrightii*) .

Disturbed prairie.—Ruderal and primitive prairie growths which come up in broken or otherwise modified prairie ground are often dominated by single plant species. The native prairie plants include the following: *Lepachys pinnata*, forming conspicuous pure growths, usually in rather dry soil; *Asclepias verticillata*, and *Lespedeza capitata*, locally abundant (rather infrequently in eastern Du Page County) in disturbed prairie along rights-of-way; *Helianthus grosse-serratus*, forming tall growths in rather moist soil; *Cassia Chamaecrista*, *Erigeron annuus*, and *Ambrosia artemisiifolia*, not very frequent; *Erigeron canadensis*, and *Lactuca canadensis*, acting quite like successful introduced weeds; *Aster multiflorus*, persisting as a prairie relic even in city lots; and *Convolvulus sepium*, an insidious creeping dominant which replaces prairie plants under changed conditions.

The prominent introduced plants are *Agrostis alba* and *Trifolium repens* in moist soil, especially with grazing; *Phleum pratense* and *Trifolium pratense*, hay plants common in rights-of-way, and in prairie which is occasionally cut for hay; *Melilotus alba*, a serious pest which has replaced extensive areas of prairie (once the prairie is broken, the sweet clover may assume complete dominance); *Poa pratensis*, very generally distributed, perhaps succeeding sweet clover after some years, in many stations; *Daucus Carota* and a number of other plants, infrequent.

Development of the prairie.—Mesophytic black-soil prairie may develop from either of two extreme types of vegetation, hydrophytic or xerophytic. The developmental series beginning in shallow water or marshy situations has been discussed by Cowles (l. c., pp. 155–156). Gates has described succession from marsh associations to the *Liatris spicata* type of prairie (l. c., p. 335, *pl. 39*). The development from grassland of pronounced xerophytic type has hardly been mentioned, with exception of that which takes place in prairie of dry sandy soil (sand prairie). The development of open xerophytic bunch-grass of sand prairie into less xerophytic types such as the *Sporobolus heterolepis-Sorghas-*

trum and *Liatris scariosa* prairie consocies has also been treated by Gates (l. c., pp. 300–303, *pl. 39*). The convergence of sand prairie and xerophytic prairie of other soils into less xerophytic prairie-grass has been described by the writer.* The more markedly xerophytic prairie-grass types are no longer present in eastern Du Page County, but may be seen in areas of older drift, as in Ogle County (Illinoian glaciation), or in still drier situations, as loess-capped bluffs of the Mississippi River (seen at Savanna, Illinois) and other prairie-grass stations farther west. Development of mesophytic prairie, from both xerophytic and hydrophytic

FIG. 7

FIG. 7. A forest border at the county line station. *Andropogon furcatus* prominent in foreground; sunflower and dogwood zones at the edge of the forest; grapevines on some of the shrubs.

extremes, may be due to action of the vegetation itself or to physical changes of environment. Retrogressive successions occur locally. Relic species from the former condition are perhaps more

* Vestal, A. G. An associational study of Illinois sand prairie. Bull. Ill. State Lab. Nat. Hist. 10: 1–96. 1913. (The black-soil transition association, p. 80.) The status of prairie associations in the southern beach areas of Lake Michigan. Jour. of Ecology. In press. (The dry prairie-grass association.)

abundant than invading species: it is probable that change in floristic composition lags behind changes in ecological conditions, due to greater or less plasticity of environmental relations in most of the plant species.

The forest border.—The forest of the area mapped is not in itself part of the subject-matter of the present discussion. Much of it is a mixed tree growth, in which basswood is very prominent. Other trees are elm, walnut, oaks (several species), hackberry, wild crabapple, choke-cherry, and wild plum. The undergrowth is made up of characteristic species of mesophytic forest, with blackberry and raspberry shrubs in more open spots.

Parts of the forest border are in apparently original condition. The undisturbed growth is of two types, first that of exposed sunny borders, best seen on south and west edges of wooded areas, and second that of shaded borders, on north edges. No east-facing borders in good condition are to be seen at the county line.

The *exposed borders* show very distinct zonation. In some places a *low-tree zone* is seen at the edge of the forest proper. This is composed of wild crab (*Pyrus coronaria*) or of plum (*Prunus americana*) or of thorn-apple (*Crataegus* sp.). These trees are usually from nine to fourteen feet in height, and form a zone of varying width. A *shrub zone* is seen just outside the trees. A dogwood (*Cornus Amomum*) dominates; hazel (*Corylus americana*) and elder (*Sambucus canadensis*) are locally abundant. The dogwood is usually three and a half feet high, the hazel is about seven feet high; the shrub zone is four to ten feet wide. Grapevines (*Vitis vulpina*) cover some of the outer shrubs and trees. The *outermost zone* is almost a pure growth of sunflowers (*Helianthus decapetalus* and *H. divaricatus*), locally replaced by a species of *Verbesina*.* The height of the sunflowers is two to four feet; the zone is two to eight feet in width. The prairie just outside the sunflower zone is strikingly uniform with that farther from the forest.

The *shaded forest borders* are less regular in composition and structure. The border of one grove, which abuts at its northern edge on a moist grassland (*Agrostis* zone, see map), was observed

* Dr. T. D. A. Cockerell has examined the specimens, which are alternate-leaved, resembling *Verbesina helianthoides*, but differing from the description of that species in that the leaves are not sessile.

to contain the following plants: thorn-apple, occasional at the edge of the forest; dogwood, in a narrow and interrupted zone next the trees; occasional shrubs of black raspberry (*Rubus occidentalis*); lianes (*Rhus Toxicodendron*, *Vitis vulpina*, and *Psedera quinquefolia*), climbing on some of the outer shrubs and trees; tall herbs (*Veronica virginica*, *Campanula americana*, *Geum strictum*); other herbaceous plants, some being prairie plants common near forest areas (*Monarda mollis*, *Pycnanthemum virginianum*), some common in swamp prairie (*Thalictrum dasycarpum*, *Oxypolis rigidior*). Less mesophytic borders, particularly at northwest-facing forest edges, are transitional between shaded and very exposed borders, the *Cornus* and *Helianthus* zones usually being present, but often very narrow. Additional secondary species of infrequent occurrence are seen.

A disturbed south-facing border near the railroad track has the sunflower zone partially replaced by Canada blue-grass (*Poa compressa*). Scattered shrubs of *Rosa humilis*, *Rhus glabra*, and blackberry (*Rubus* sp.) are invading the grassland at some little distance from the woods.

Summary.—The county line station, a half-hour's ride west of Chicago, contains areas of prairie, forest, and forest border in still fairly good condition. Preservation of the forest from former prairie fires is suggested by its location on the east side of a line of prairie sloughs. The prairie, like that of other stations in this part of Illinois, is largely mesophytic; this type is of three appearances: (1) the *Andropogon furcatus* prairie, (2) the mixed grass prairie, and (3) the *Silphium terebinthinaceum* prairie. Mesophytic prairie-grass may be derived either from marsh growths and swamp prairie or fen, small areas of which are still abundant near by, or from xerophytic prairie-grass, represented in the area chiefly by *Silphium laciniatum* prairie. The markedly xerophytic types of prairie-grass no longer persist in upper Wisconsin glaciation of northeastern Illinois, but are well represented in central and western parts of the state. Sunny forest borders show an outer zone of sunflowers, a shrub zone of dogwood, occasionally with hazel or alder, and sometimes a low-tree zone, in which plum, thorn-apple, or wild crab may be seen. Shaded borders show less definite and narrower zones, with tall mesophytic herbs, climbers, and usually dogwood.

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Mechanical tissue development in certain North American vines*

HOWARD H. M. BOWMAN

During the year 1912, a study was made of various woody vines growing in temperate North America, with the idea that there might be some relation between them and intermediate forms bearing on the origin of the liana habit in these temperate regions. This paper refers more particularly to the mechanical tissues of these plants.

The liana habit of course shows no phylogenetic connections and in this respect is analogous to parasitism, saprophytism, etc. The habit evidently did not arise early in the temperate zone since among the plants indigenous to this zone it is developed to a very slight extent among the lower orders, Liliales perhaps being one of the first, that is, on the arbitrary basis of the coördination of structure with time of origin. In the tropics, however, the monocotyledonous families having the liana habit are much more numerous, e. g., some bamboos and various members of the Palmaceae, Pandanaceae, and Araceae, etc. But if, as some recent investigators (see Henslow, 5) conclude, the monocotyls arose from the dicotyls, this theory of chronological origin may be discredited altogether. At any rate, it is fair to suppose that the habit did not arise until there was such dense vegetation as to make the habit an advantage to the plant. Most of the lianas, according to Schenck's estimate (see Schimper, 7, p. 197) ten elevenths, are tropical because the conditions in the tropical rain forests are the causative factors, i. e., deficiency of light and abundance of moisture.

However, the simplest internal physiological reason for the origin of this vine habit seems to be the lack of adequate mechanical tissues. A secondary factor is the lengthening of the internodes but this is due to the evident physiological process of elongation by diffuse light reaction. This can easily be accounted for by an

* Contribution from the Wolff Biological Laboratory, Franklin and Marshall College, Lancaster, Pennsylvania.

adaptive line of reasoning since the vine habit is most prevalent in habitats of diffuse light and plenty of water. As Schimper (**7**, p. 309) says, the origin of both lianas and epiphytes is to be traced to a low intensity of light and an abundance of moisture. But the lack of adequate mechanical tissue is not well accounted for. To attempt to explain this it seems to be necessary to look at the plant characters from a genetic point of view. Clearly the amount of mechanical tissue is a unit character in a plant and any variation in this direction affects this character. In the course of the formation of the ancestral germs of plants showing this habit there must have occurred a dissociation of characters and this segregation of characters associated together in the normal ancestor gave rise to their present form; since Bateson (**2**) says segregation thus defines the units concerned in the constitutions of organisms and provides the clue by which an analysis of the complex heterogeneity of living forms may be begun. Right in the line of this investigation is the peculiar phenomenon observed by de Vries in his *Oenothera* cultures in the specific example of *Oenothera rubrinervis*, which has among other characters bast fibers with thin walls. According to de Vries's observations *O. rubrinervis* arose once in every thousand seedlings and twelve times in cultures not in the direct line of descent, i. e., from the pure *O. Lamarckiana* family. In this instance de Vries thinks that if the group of *rubrinervis* characters could be dissociated, then its compound nature would be disclosed. How the unit can cause the bast walls to become thin cannot be explained, but he insists that the habit of a species can be so much altered by mutation that during its whole life and in every organ it differs from its parent species (**8**). Now, just as this could happen in *Oenothera rubrinervis*, could there not be a similar segregation and recombination of different characters so as to cause a decrease in the mechanical tissue of any plant in a period of mutation?

With this question in mind an examination of the stems of various plants in diverse families found in the temperate zone was made to see if there was a warrantable deficiency in mechanical tissue development to account for the inability of these plants to stand erect. This group of plants was composed of the following: *Rhus Toxicodendron*, var. *radicans* (L.) Torr., *Psedera quinque-*

folia (L.) Greene, *Vitis vinifera* L., *Hedera Helix* L., *Akebia quinata* L., *Rosa polyantha* L., *Lycium halimifolium* Mill., *Wisteria frutescens* (L.) Poir., *Lonicera japonica* Thunb., *Tecoma radicans* (L.) DC., *Rubus occidentalis* L., and *Kerria japonica* L.

The *Lonicera* was first examined and, as de Bary (1, p. 532) observed, this plant has a simple arrangement of its tissues, producing one zone of bast fibers and one of soft bast each year. This inner zone is just on the inner boundary of the bast and the wood fibers are disseminated in the xylem in single radial rows. The arrangement of fibrous strands gives sufficient tensile strength but is not enough to permit the plant to stand upright. These bast strands are not close enough together to give adequate support in an upright position. Under the epidermis the cortical parenchyma is somewhat thickened but as a source of mechanical support this is almost negligible. The wood cambium consists of ordinary parenchyma. Inside the soft bast zone between it and the pith there is a parenchymatous tissue called by Strasburger *vascular parenchyma*. This may give some support, particularly under a tension. The vascular elements occupy the remaining space. In older stems of the *Lonicera* of course the secondary tissues give considerable stability to the stem, but the primary xylem of a first year stem is not nearly enough to enable the stem to maintain a perpendicular position.

The stem of the *Akebia* is angled and for each ridge there is a large vascular bundle, oval in cross section. The bundles fill most of the space in transverse section. The most important mechanical tissue is the bast, which forms a small cushion, four or five cells in thickness, on the outer edge of each bundle. The bast fibers are heavy and have very small lumina but they are deficient in number. The cortical parenchyma is assimilative in the *Akebia* and therefore has very thin walls. The primary xylem is not important from a mechanical standpoint in this plant; the conductive elements occupy 58.3 per cent, while the mechanical tissue occupies only 8.3 per cent of the transverse area, i. e., a ratio of 7 to 1. The bast cells in the *Akebia* are thicker than those of the *Lonicera* but the numerical proportion is smaller.

In *Hedera Helix* the most noticeable feature is the narrowness of the medullary rays, which are only one cell thick. The mechan-

ical tissues are represented only by the xylem and the small amount of bast next to the outer cortex parenchyma. A peculiar feature of this latter is that under certain conditions it is greatly increased and bush forms of the *Hedera* can be noted in many gardens. The occurrence of this form as a variety is frequently noted in botanical literature (see de Vries, **8**, vol. 1, p. 44). This would go to show that in the ivy, if it grows as a bush, i. e., if it is well fertilized and pruned, the bast elements will develop to such a degree that it can maintain an erect position. The shock of pruning seems to cause this undue development of bast. This plasticity of the stereome development offers ground for the theory that the liana habit arose from erect plants.

In the *Rhus* there are almost no medullary rays to be clearly distinguished, the primary xylem is well developed and in the phloem the resin ducts are seen, as mentioned by de Bary (**1**, p. 452). The mechanical tissues are poorly developed in primary growth except the collenchyma, of which there are approximately three layers of cells. In the secondary growth the bast fibers are parallel in development with the secondary wood. In the *Rhus* the estimate is 39.51 per cent for the vascular elements.

The *Wisteria* shows the greatest development of sclerenchymatous fibers with very heavy walls, so that they appear almost solid. In the wood cambium and the cortical parenchyma there are a great many calcium oxalate crystals and in the latter region are also many irregularly shaped stone cells. These give the plant considerable strength, but there are not enough of the long fibers to produce a solid cylinder. A young plant with this amount of mechanical tissue can keep an erect position until it is a half meter high, when the weight of the increasing growth becomes too great for these tissues and it assumes a recumbent position. This was observed in young plants grown under various conditions and in different situations. The leaning position is assumed much earlier in diffuse light.

There are peculiar conditions in the mechanical development of the *Lycium*. This plant is half shrub and half vine. Its manner of growth is most interestingly discussed by Kerner von Marilaun (**6**, vol. 1, p. 672). The xylem occupies a very large space and the bast is developed so as to fill 18 per cent of the transverse area.

The pith and the parenchyma of the cortex also occupy relatively large spaces and contribute nothing to support. In this plant the characteristics of the ivy are again reviewed. If the *Lycium* is grown in open situations, such as fields, the plants can make a growth of several meters before becoming entirely prostrate, and if pruned will form a dense, shiny shrub. If it grows in diffuse light near a support, however, the characteristic "leaner" habit or, as Kerner von Marilaun calls it, the "weaving" habit, is developed.

The *Psedera* has a very definite arrangement of the mechanical tissues. The xylem occupies almost a continuous cylinder outside the pith, the rays separating the bundles being very narrow. In the wood cambium the bast fibers conform to the type called by de Bary branched sclerenchymatous fibers, forming a continuous cylinder with a thickness of six cells. This makes the stems very tough and by experiment in the laboratory it was found that a stem of one season's growth, 70 cm. long and 0.3 cm. in diameter, bore a strain of 8845.2 grams before breaking but could not support an erect position in a stem of the same dimensions more than 70 cm. in length. These sclerenchymatous fibers in transverse action measured 0.06–0.08 mm. in their greater dimension and 0.01–0.02 mm. in the shorter, the sections being irregularly oblong; the lumina were about 7 μ wide, thus showing the walls to be comparatively heavy. According to the above experiment, however, the fibers do not suffice to maintain the stem in an upright position.

The arrangement in the *Vitis* is similar to the preceding in a great many respects. The xylem is here developed to a greater extent and this gives a considerable support. The medullary rays are clearly defined and also the cambium ring. In the *Tecoma* there is very good reason for the toughness of the stem. In transverse section, by measurement it was seen that in a belt of the cortical parenchyma 0.9 mm. wide there were thickly scattered groups of short sclerenchymatous fibers and also a heavy reinforcement in the external layer of collenchyma. The stem, too, occupies a large area. In fact, in the *Tecoma* the vascular elements occupy 33⅓ per cent of the stem and the secondary thickening is, of course, very interesting. Haberlandt (4, p. 629) remarks that Sanio first observed that the wood and bark formation took place in the reverse order from most plants.

However, as the secondary thickening is not considered in this study, its details will not be mentioned. A peculiar though common phenomenon is seen in the *Tecoma* in that there is a great increase in the parenchymatous tissues on the side from which adventitious roots or holdfasts are put out, so that there is a great differential growth seen in transverse section.

In the *Rosa*, which is a "leaner" or "weaver" according to Kerner von Marilaun's terminology, the vine habit is almost lost. This is like the *Hedera* inasmuch as it has so much plasticity that by proper culture it can be made to assume a tree-like or shrub-like form. The mechanical tissues are well represented, the large, thick-walled fibers form an interrupted sheath in the transverse section and there are also many large crystals of calcium oxalate in the peripheral region; the collenchyma is very thick-walled and the xylem is arranged in numerous narrow bundles separated by frequent, though attenuated medullary rays. The *Rubus* shows very similar characters. This genus is also included in Kerner von Marilaun's weaving category, but it has various species in southern Asia and Australia which are typical lianas. In both *Rosa* and *Rubus*, of course, the pith area is very large in cross section. In the *Rubus* the bast fibers form a heavy belt and the collenchyma too is developed to six layers of cells. The last species studied, *Kerria japonica*, is a weak shrub and never develops any vine habit. In this plant, however, the mechanical support does not seem to come so much from the bast fibers, etc., as from the principle of construction, i. e., a very firm outer cylinder filled with pith. The bast fibers are large but few in number and scattered in small groups, the perennial epidermis doubtless also contributing to the stability of the stem as also the lignified tissues of the very broad, flattish vascular bundles.

Now in looking over the anatomy of this group of plants it would seem that the variation in stereome elements in stems would naturally be a factor of great importance in the evolution of the vine habit. Of course the first and most important agent is light, since light by its action on the chloroplast tends to change the shape of the cell. Diffuse light is known to cause an elongation of parenchymatous cells and this of course produces elongation in an organ. This then partially accounts for the elongated habit of

vines but why there should be also a decrease in the mechanical tissues or at least an inefficiency in support for the stem can not be explained on this basis. The fact that reduced photosynthesis due to shade can bring about a decrease in constructive tissues might seem of some importance, but plants that have the habit develop characteristically in full light as well as shade so this argument is negligible.

So it would seem that there must be some basis for argument in support of the position taken before, viz., that in the light of de Vries's classic experiment on *Oenothera* the mechanical tissue development has its origin in the unit characters of the plant. As these are partially dependent on nutriment in the ancestors it follows that there must have been considerable variation in the premutation stages of the vines studied. As de Vries says all mutations are not progressive, i. e., visibly differentiated, we may speculate and suppose the plant to have undergone a retrogressive mutation which produces a change, a decrease in the bast fibers, etc. These characters then of the normal type have become latent or suppressed and may be retained as internal units, e. g., in the *Hedera* and at a future time under proper conditions may become activated. When once the plant has become a "leaner" by deficiency in mechanical support the secondary result of diffuse light can produce its effects towards elongation. However, this is speculation and mere argument based on *a posteriori* grounds. As stated above, all mutations need not be advantageous, and the first stages in the vine habit may have been distinctly disadvantageous. It may be said that the primary variation in mechanical tissues is due to recombination of the characters of certain plants and that plants with vine habits arise as mutations due to the preceding causes. In conclusion a quotation from the Chicago Textbook (**3**, p. 656) may give the general idea of this line of evolution: "It is assumed, and probably correctly, that lianas have come from erect ancestors, and that their evolution was subsequent to that of trees. . . . Probably the first lianas were leaners, the twiners and tendril climbers developing later."

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The nomenclature of the genus Usnea

R. Heber Howe, Jr.

(with plates 9–14)

In my first paper on the genus *Usnea* (Bull. Torrey Club **36**: 309–327. *pl. 21–23*. 1909) I made no attempt to solve the nomenclatural questions presented in this genus. In my second paper (Bull. Torrey Club **37**: 1–18. *pl. 1–7*. 1910) I located the types of the species concerned and attempted to use determinations made of the Dillenian types by Crombie to elucidate the problem of the Linnean species. In a still later paper (Bull. Torrey Club **37**: 605–609. 1910) I made further notes based on Dr. Wainio's report on the Linnean types. These three papers presented the nomenclature of the Linnean species as follows, as compared with Tuckerman's and Dr. Zahlbruckner's treatments.

Tuckerman, based on E. Fries:

Usnea barbata (L.) Fr.
barbata a. *florida* Fr.
barbata a. *florida* **hirta* Fr.
barbata a. *florida* ***rubiginea* Michx.
barbata b. *ceratina* Schaer.
barbata c. *dasypoga* Fr.
barbata d. *plicata* Fr.
barbata e. *articulata* Ach.

Author's 1909 paper:

Usnea barbata (L.) Fr.
barbata florida (L.) Fr.
Contingent phases: *Usnea barbata hirta*
barbata rubiginea
barbata florida f. *strigosa* Ach.
barbata ceratina (Ach.) Schaer.
barbata dasypoga Fr.
barbata plicata Fr.
barbata articulata Ach.

Author's 1910 paper, based on Crombie:

Usnea florida (L.) Web.
Cont. phase: *Lichen hirtus* L.
Usnea florida Michx.
Usnea plicata (L.) Web. = *Usnea ceratina* Ach.
plicata var. *barbata* (L.) R. H. Howe = *Usnea dasypoga* (Ach.) Nyl.
articulata (L.) Hoffm.

Author's 1910 paper, based on Dr. Wainio:
Usnea florida (L.) Web.
Syn. *Lichen hirtus* L.
plicata (L.) Web. = *Usnea ceratina* Ach.
barbata (L.) Web. or *U. plicata* var. *barbata* (L.) R. H. Howe = *Usnea dasypoga* (Ach.) Nyl.
articulata (L.) Hoffm.

Dr. Zahlbruckner; Engler & Prantl, Nat. Pflanzenfam.:
Usnea florida (L.) Hoffm.
ceratina Ach.
dasypoga (Ach.) Nyl.
dasypoga var. *plicata* (Hoffm.) Hue
articulata (L.) Hoffm.

The only correction made by me,* which has had general adoption, is the acceptance of Weber as the first author responsible for the combination *Usnea florida* as a binomial.

During the year 1912, through the kindness of Dr. S. H. Vines and Dr. B. Daydon Jackson, I had the opportunity to study both the Dillenian and Linnean herbariums and also authentic Fries and Acharian material. I here present photographs of the types and trust that the problem may now be considered settled beyond all doubt.

Series: *Mesinae*

Chondroid axis one third the diameter of thalline filament.

Usnea florida (L.) Web. I find two type specimens preserved in the Linnean herbarium in the apartments of the Linnean Society, Burlington House, London. They are mounted on one sheet labeled *Lichen floridus* in Linné's handwriting, with the Flora Suecica (1745) number 991 written below the specimens. These are typical (as long understood) and are well described in the original description.

* Brought to my notice by Dr. J. H. Barnhart.

Usnea florida f. *hirta* (L.) Ach. I find three types of this sorediate and generally sterile form of *U. florida* preserved in the Linnean herbarium. One of these bears the Flora Suecica number of *Lichen plicatus*; the other two are atypical (as now understood). The original description is diagnostic.

Usnea plicata (L.) Web. I find no true type specimen in the Linnean herbarium. A specimen, probably only a portion of the original plant, answering poorly to Linné's description, is in his herbarium labeled *Lichen hirtus*, but with number 984 (the number of *L. plicatus* in Flora Suecica) written below the specimen. Thus with no definite type, I have endeavored to interpret the Linnean description, and the Dillenian plate (and his type) to which Linné refers and on which Linné based his *Lichen plicatus*. The Dillenian plate and specimen answer perfectly to the Linnean description and must be considered the only sound evidence available, by means of which the status of *Lichen plicatus* L. can be settled. The Acharian *plicata** represents the same plant and is not the plant often referred to as var. *plicata* (Hoffm.) Hue. There seems no doubt whatever that though *plicatus* L. and *U. ceratina* Ach. are synonymous (as commonly understood of late in this country and in Europe), we must not consider them identical, no matter with what plants we have since associated the names. The error has arisen through a misunderstanding of *ceratina* of Schaerer and *ceratina* of Acharius, the latter author having priority for the name. The Dillenian type was not determined by Acharius *ceratina* as it was by Schaerer, and as we find Crombie labeled it, and as the Acharian synonymy and material here figured goes to show.† Acharius's *plicata* is the same plant that Linné called *Lichen plicatus*; in other words the *coarse*, *pendulous* (partially papillo-sorediate but *not* "asperrimo") species of the middle Atlantic States from where the American Dillenian type came (Pennsylvania), and a type locality cited by Linné as directly taken from Dillenius. I cannot see that we are in need of any further data. *Usnea plicata* Hoffm. is therefore also preoccupied, and in Hoffman's own herbarium, moreover, is represented, Dr. Wainio tells us, by a plant referable to *florida* of Fries.

* Based on Linné and Dillenius, see Lich. Meth. 310. 1803.

† See remarkable plate by Westring, Sven. Lafv. Faerghist 69. 1805, showing complete structure.

Usnea ceratina Ach. Through the kindness of Dr. Elfving I am reproducing a photograph of the type of this species. It does not occur in temperate North America and appears to be as Acharius made it a *prostrate* and entirely *asperate* species, perhaps as Dr. Jatta calls it synonymous with *U. coralloides*, *aspera* Eschw.,* and certainly *totally* unlike the papillate or partially sorediate and *pendulous* species recognized as *ceratina* (No. 95 Decades No. Amer. Lich., Cummings) or as the especially luxuriant specimens *U. californica* Herre, which may deserve subspecific rank.

Usnea barbata (L.) Web. In my former paper I adopted the name *barbatus* L. as synonymous with *dasypoga* Ach. and pointed out that I believed it to be the proper name for this variety, but my argument was based on Crombie's partially inaccurate statement in regard to the Dillenian type, and also on account of the ("Europae & Americae *septentrionalis*") type localities. My reasons heretofore stated were that the Dillenian type was said by Crombie to be *Usnea dasypoga* (Ach.), and also the ruling of early post Linnean authors Westring, Hoffmann, and Fries (see author's Class. *Usneaceae* 14. 1912). An examination of the Dillenian type, a figure of which is here published, shows it to be composite, *Usnea articulata* and *Usnea dasypoga* mounted on the same sheet. In an examination of the plate of these plants a few semi-inflated articulations (explaining Linné's "subarticulatus") are to be found,† as appears to have been the case in the plant, and Dillenius seems to have ignored the other specimen as he figures it in another and entirely typical plate illustrating his *Usnea capillacea* et *nodosa*, = *Lichen articulatus* L. It would seem therefore so far as Dillenius is concerned that his type is composite, though not his plate, and by his plate he himself contradicts the duplicity of his type. In the Linnean herbarium, however, we find no type of *articulata*, but a single and perfect specimen of *barbata* which answers exactly to our modern conception of *articulata*. According to Dr. B. Daydon Jackson, however, Linné must have based his *Lichen barbatus* entirely on Dillenius, for he did not have a specimen of it in his own herbarium until 1767 (Index Linn. Herb., Supp. Proc. Soc. 96. 1912). One is therefore left with

* A caespitose, erect, not prostrate species.

† A condition not infrequently met.

two alternatives, the first plainly defying Linné's intention, i. e., to use *articulata* as a synonym of *barbata*, turning to Acharius's name for the present plant, either exactly as he proposed it or as combined by Nylander. The other, to accept Linné's descriptions of both *Lichen barbatus* and *L. articulatus*, which are diagnostic and (except for the composite type conditions referred to) as Dillenius figured and understood them, for the two descriptions leave no doubt that Linné intended to indicate two different plants. This latter procedure is it seems clearly the proper one, soundly based and entirely satisfactory.

Series: *Leptinae*

Chondroid axis one fifth diameter of thalline filament (internodal section).

Usnea articulata (L.) Hoffm. I find in the Linnean herbarium one sheet labeled 72 *barbatus* by Linné, which represents the typical plant generally recognized as *articulata* (L.) Hoffm. As already shown Linné was describing another species, based entirely on Dillenius, when he named *Lichen barbatus*, as this specimen was not acquired until 1767, twenty-two years after he first described it. Linné's description is diagnostic, and his type locality an added argument.

Our North American Linnean species therefore stand as follows:

Usnea florida (L.) Web.

plicata (L.) Web. = *U. ceratina* Schaer. non Ach.

barbata (L.) Web. = *U. plicata* var. *dasypoga* Ach.

Usnea articulata (L.) Hoffm.

One cannot emend and adopt the Acharian name *implexa* for the plant known as *U. dasypoga* var. *plicata* (Hoffm.) Hue, a name absolutely untenable as preoccupied by a recognizable plant, as Acharius himself finally made it a synonym of his own *plicata*. Again, as I have said, Hoffmann referred to the same Dillenian plate (*pl. 11, f. 1*) as Linné did, and the plant so named in the Hoffmann herbarium is curiously enough *florida* of Fries. One must therefore turn to Schaerer and adopt his variety *stricta**

* Orig. desc. "ramis simplicissimis, stricta" Spicil. 507. 1840; "straminea, subdichotoma, flaccida, pendula, tenera, ramis simplicibus, strictis, efibrillosis." Type loc. "sylv. alpin. Helvetiae." Enum. crit. Lich. Europ. 4. 1850. Latin *strictus* = straight.

as he seems to be the first author to recognize this simple, naked variety of *barbata*,—which plants can be hailed as *Usnea barbata* var. **stricta** (Schaer.) comb. nov., a name that antedates *Usnea barbata* var. *intermedia* Mass., given seemingly to the same plant.* The question now presents itself, shall botanists consider these actual specimens in the light of types. Whether they do or not seems of little importance. The investigation of them has led to an understanding of really what plants Linné named, and this I take it is what we most desire to know if we are ever to place our nomenclature on a sound basis. My view taken in 1910 is therefore unchanged, except in the realization that *Usnea ceratina* Ach. is not synonymous with the plant (Linné's *plicatus*) Crombie, Tuckerman and many other recent authors (based on Schaerer) supposed, but is a distinct and very different species. Dr. Zahlbruckner's work fails to take account at all of the coarse, pendulous plants, i. e., *ceratina* of Schaerer or *plicatus* of Linné, as he cites only *ceratina* of Acharius.

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EXPLANATION OF PLATES 9–14

PLATE 9

UPPER FIGURE. The Linnean type of *Lichen floridus* in the Linnean herbarium (reduced one half).

LOWER FIGURE. The Acharian specimen of *Lichen comosus* in the Linnean Society herbarium (reduced to two fifths actual size).

PLATE 10

The Dillenian type of *Usnea vulgaris*, etc., incorrectly referred by Crombie to *U. ceratina* Ach. (reduced one half). It also represents Linné's conception of his *L. plicatus*.

PLATE 11

UPPER FIGURE. The specimen in the Linnean herbarium bearing the Flora Suecica number 984 of *Lichen plicatus;* labeled *hirtus*, and representing one of the types of the latter species (slightly reduced).

LOWER FIGURE. The Acharian type of *Usnea ceratina* (slightly reduced).

PLATE 12

The Acharian specimen of *Usnea plicata* in the herbarium of the Linnean Society in London (reduced one half).

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* See *U. barbata*, f. *Schraderi* Dalla Torre & Sarn. Flecht. Tirol., etc. 4. 1902.

PLATE 13

The Dillenian types of *Usnea barbata*, etc. (reduced one half).

PLATE 14

LEFT-HAND FIGURE. The Linnean specimen of *Lichen barbatus* in the Linnean herbarium (slightly reduced). This specimen has little claim to be considered a type because of its acquisition twenty-two years after the species was originally described.

RIGHT-HAND FIGURE. The Acharian material of *Usnea barbata*, var. *articulata* (L.) Ach., in the Linnean Society herbarium (reduced one half).

Observations on the edge of the forest in the Kodiak region of Alaska*

ROBERT F. GRIGGS

(WITH ONE TEXT FIGURE)

As is well known, the western limit of the Alaskan spruce forest, composed of *Picea sitchensis*, crosses Kodiak Island. The forest on the northeastern portion of the Kodiak group of islands consists of fairly large trees forming a dense stand but further westward the trees are much smaller and grow only in the more sheltered situations, finally failing altogether. The last of them that we saw as we went down the outside coast were on Ugak Island while the furthest extension on the opposite inside coast is at Cape Uganik.

The edge of the coniferous forest is generally spoken of as the edge of the forest but it is by no means the limit of arborescent growth. For both the paper birch, *Betula papyrifera alaskana*, and the cottonwood, *Populus balsamifera*, though mapped by Harshberger† as terminating at the head of Cook Inlet, reach Kodiak Island and extend for many miles beyond the last spruce, growing abundantly in suitable habitats. In our trip around the island we saw the last of them on Two-headed Island, beyond which the country was a treeless grassland or tundra. Coming back on the opposite side we met them again at the entrance to Uyak Bay.

Our nearest stopping place to their limits was at Three Saints Bay. Here the birches occurred singly on the edges of the bogs, reaching a height of about fifteen feet. The poplars grew in clumps on the better drained land. They were about twenty feet tall and somewhat deformed but the deformation was somewhat less marked than in the outermost spruces. The largest plants

* Contribution from the Botanical Department of the Ohio State University, No. 81. The writer's opportunity to visit this interesting region came with his employment during the summer of 1913 as scientist in kelp investigations by the Bureau of Soils of the United States Department of Agriculture.

† Harshberger, J. W. Phytogeographic survey of North America. Veg. der Erde 13. 1911.

were less than a foot in diameter. These small plants contrasted strongly with those seen later at Kalsin Bay about 55 miles northwestward, which were large trees 60–80 feet tall and 2 feet in diameter. Very much to our regret in view of the conditions later found on the edge of the spruce forest we did not obtain data as to the comparative ages of these trees.

As opportunity presented, observations were made on the fruiting habits of the spruce and the birch; the poplar was not seen in fruit. Most of the trees of both species bore little fruit but some few of them were fruiting copiously. This matter varies much,

FIG. 1. Stunted Alaskan spruce (*Picea sitchensis*) on Afognak Island, near the edge of its range.

however, from season to season. Fernow* reports that the year 1898 was a heavy seed year for the spruces, which bore an enormous crop of cones, which, turning brown and persisting on the branches through the summer of 1899, "gave the trees at a distance the appearance of having been killed by fire."

Near the edge of the spruce forest it appeared very evident

* Fernow, B. E. The forests of Alaska. Harriman Alaska Exped. 2: 245. 1910.

that conditions were unfavorable for growth, and that the trees were barely able to maintain themselves. When growing alone their shape contrasted strikingly with the familiar slender spires seen further east. They were squatty and broad with thick stocky trunks (FIG. 1) and evidently grew very slowly. They did better when growing in clumps but the dependence of the individuals on the protection of the clump as a whole was very striking. Regardless of the age of the trees there was a very definite clump-contour beyond which no single branch projected. The growth of the individual members was evidently conditioned on that of the clump. Each tree was kept in exact proportion to its neighbors. The trees in the center were the tallest while those near the edges were progressively shorter and shorter until those on the edges were nearly as much dwarfed as those standing alone.

Apparently here was what I had looked for in vain in studying species on the edges of their ranges in the Sugar Grove area of Ohio,* namely a species which had reached the limits imposed by climatic conditions so that it could go no further. The climatic extreme in this case would appear to be Merriam's "Effective Temperature Factor" which has been positively assigned as the cause by Piper,† who says "Undoubtedly this effective temperature factor is the principal cause of the sharp demarkation between the timbered and timberless regions on the Alaska coast."

As far as observation could determine, then, here was a clear-cut case of a species which had reached the limits imposed on its extension by its adaptability to climatic conditions. But as a matter of fact this is not at all the case for *the edge of the range of the spruce is not held stationary but is advancing rapidly.*

The advance is so rapid that it is evident to persons who have lived in Kodiak only a few years. According to Mr. M. D. Snodgrass of the Experiment Station all of the old men of Kodiak remember when there were but a few trees on Woody Island which is now heavily forested. On Near Island there are large numbers of young trees coming in on land that was never forested before.

* Griggs, R. F. Observations on the behavior of some species on the edges of their ranges. Bull. Torrey Club **41**: 25–49. *f. 1–6.* 1914.

† Piper, C. V. The grasslands of the South Alaska coast. U. S. Dept. Agr. Bur. Pl. Ind. Bull. 82: 27. 1905.

Mr. Snodgrass himself has observed the advance of the spruce on the station lands at the head of Kalsin Bay, which is within a few miles of the extreme edge of the range. Land which was prairie pasture six years ago when he came to Kodiak is now growing up in spruce.

This unstable condition of the edge of the forest has already been reported by Fernow* who says:

"There is some evidence that this western limit is not, or may not remain, stable—that the spruce has wandered in recent times and may still wander. There is also evidence that the treeless country beyond, made up of the Alaska peninsula and the Aleutian Islands, is not incapable of growing trees.

"An interesting evidence of the progress of the spruce may be seen on Long Island, a few miles east of Kadiak, where an extensive spruce grove has established itself within the last century. Many trees had been freshly cut and a count of the rings showed none older than ninety or a hundred years. While on Kadiak and Wood Islands the oldest growth was found to be between 125 and 150 years with some few rotten stumps possibly older. This difference in age of entire groves so near together allows the inference that the older has furnished seed for the younger and that the spruce has wandered from Kadiak to Long Island."

It might seem a simple matter of arithmetic to determine from the data at hand the rate of advance of the spruce forest. This however is not the case. The probability is that the advance goes by long jumps at considerable intervals of time. Fernow (l. c.) pointed out that it is conditioned on the conjunction of a good seed-year and a favorable wind, the prevailing winds being adverse. The limits of the spruce which he reports are exactly the same as those we observed after an interval of fourteen years. It must be clear also that after one step forward, further advance is delayed until the trees along the newly established boundary begin to fruit and in their turn supply seed for further invasion. Thus while it may be that there was no actual advance during this fourteen-year period, it is clear from Mr. Snodgrass's experience that the vanguard has been spreading over the newly acquired territory and strengthening itself, so to speak, for another move forward.

* Fernow, B. E., *l. c.* 244.

The advancing forest at Kodiak is peculiarly significant because it is a typical example of the kind of evidence upon which most of the assumptions of static plant ranges have been based. The edges of the forests more than any other vegetational lines have been used to show the correlation of plant ranges with climatic factors. Such work is all based on an assumption of complete adjustment of plants to climate and loses its significance wherever such adjustment does not exist, i. e., wherever the ranges are not fixed but changing. Our knowledge of the conditions obtaining at the limits of forests except in a few cases has all been derived from reports by travelers of stunting and apparent struggle against climatic extremes has seemed conclusive just as similar observations appeared conclusive to the writer at Kodiak. In few cases has the history of the regions been examined to find the actual facts.

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INDEX TO AMERICAN BOTANICAL LITERATURE

1913–1914

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

This Index is reprinted monthly on cards, and furnished in this form to subscribers at the rate of one cent for each card. Selections of cards are not permitted; each subscriber must take all cards published during the term of his subscription. Correspondence relating to the card issue should be addressed to the Treasurer of the Torrey Botanical Club.

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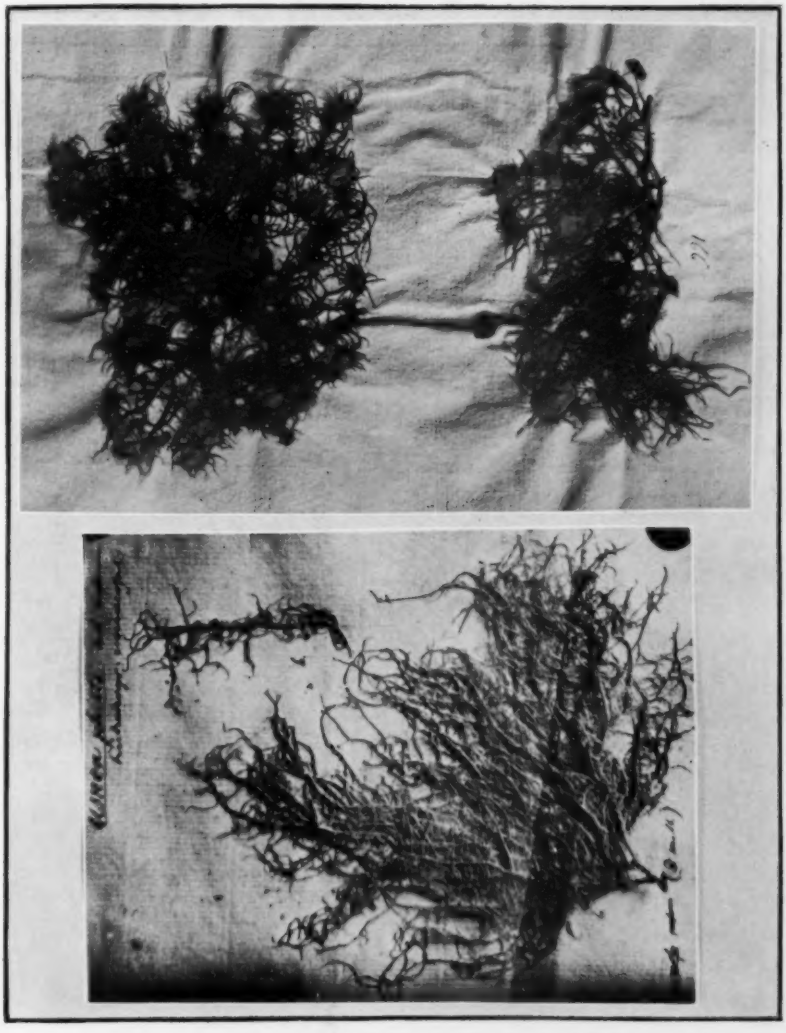

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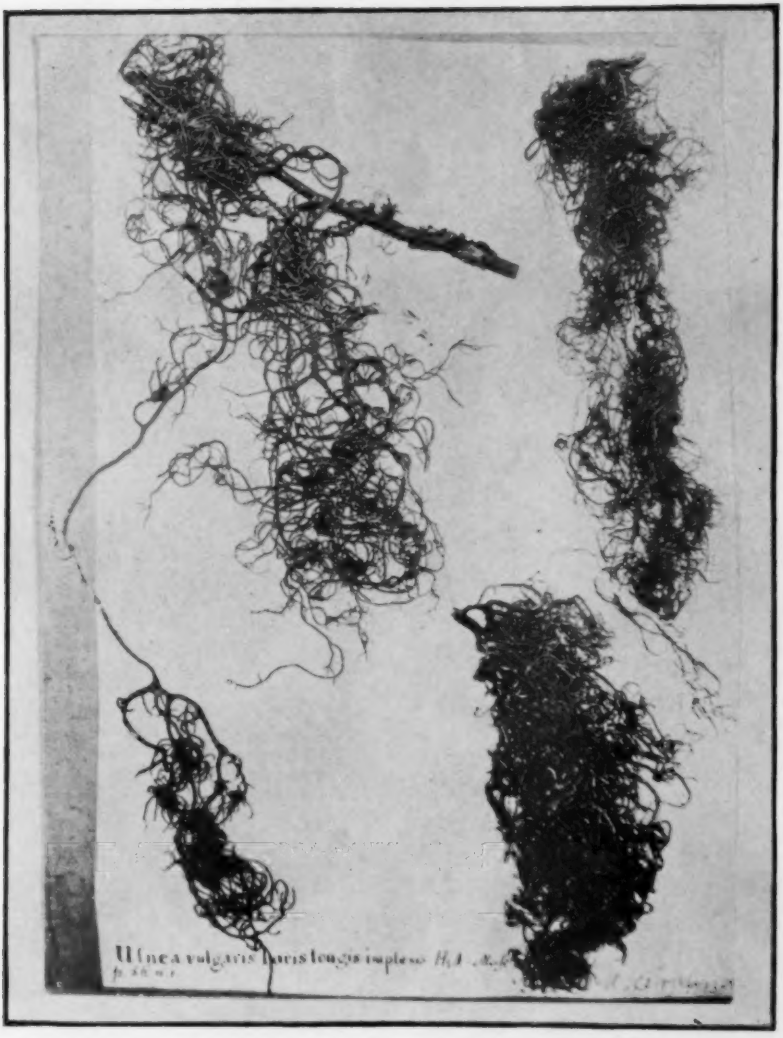

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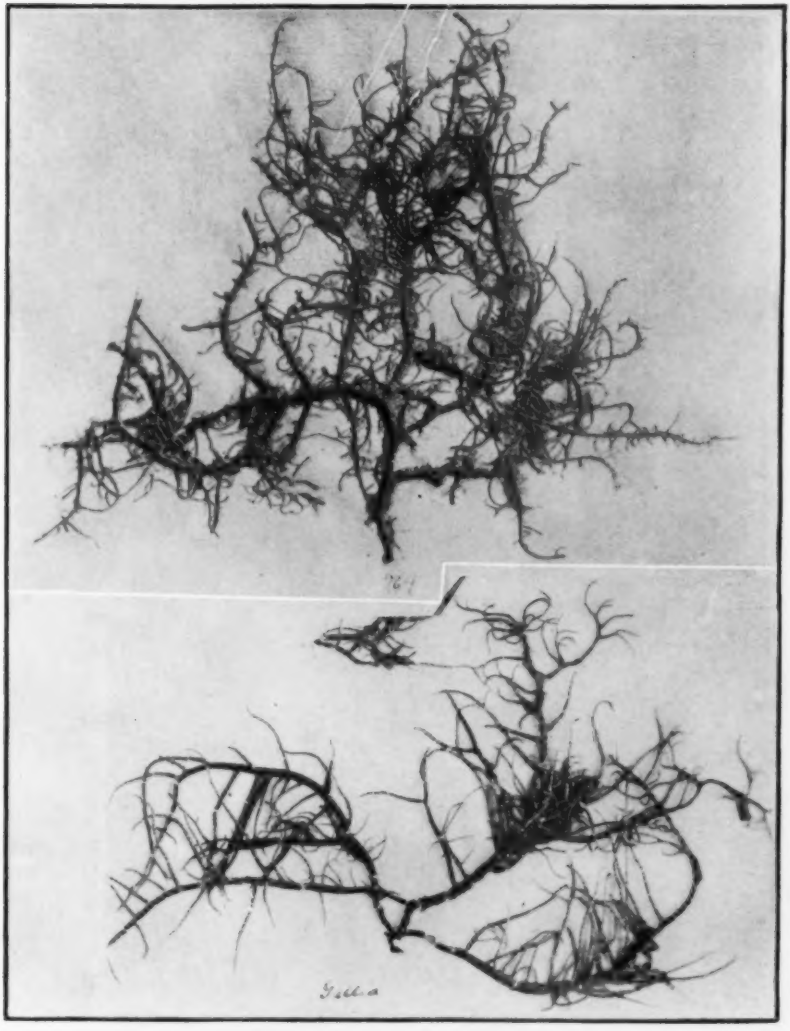

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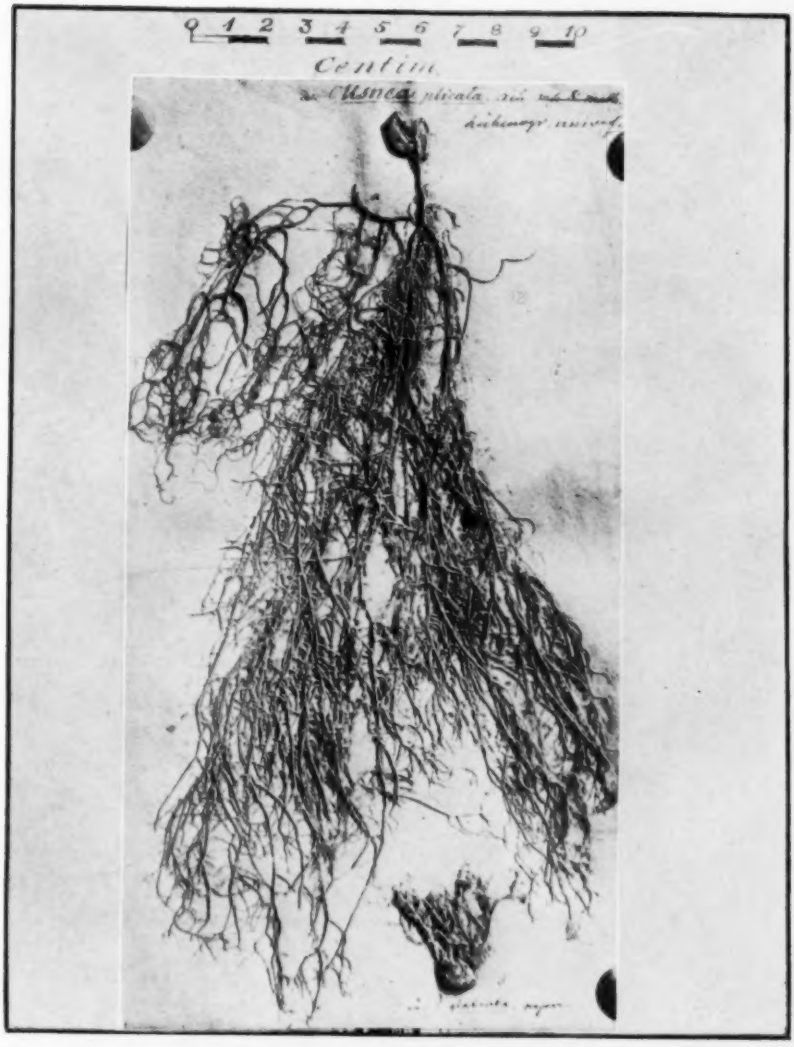

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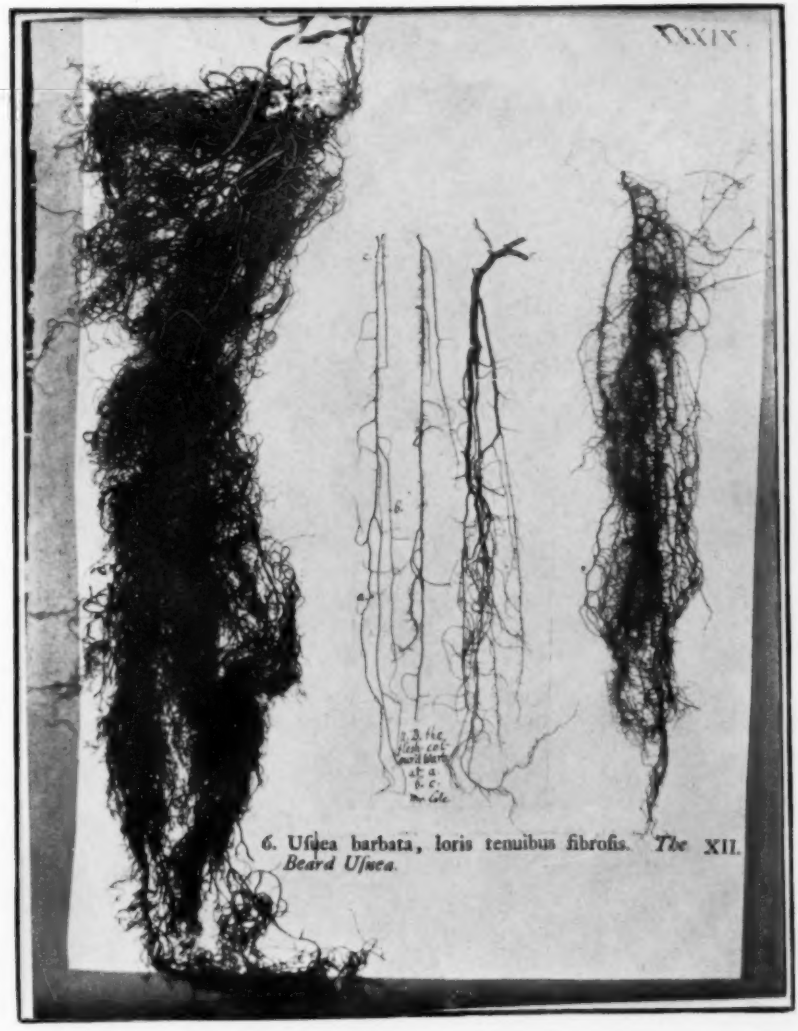

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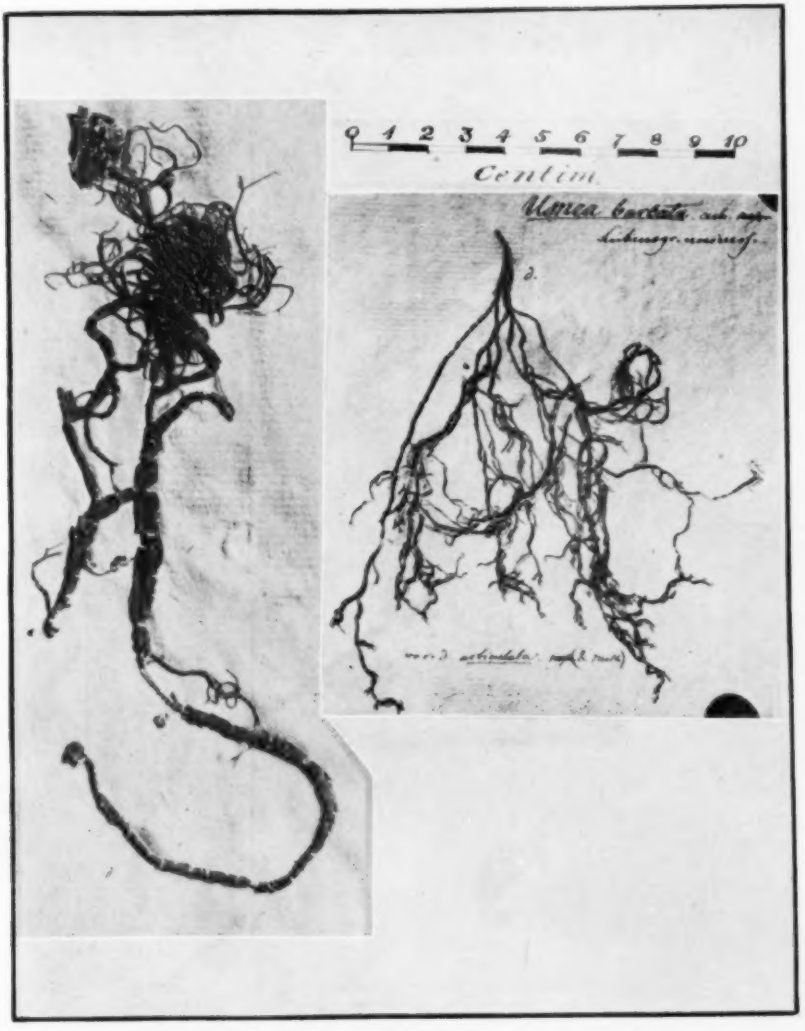

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